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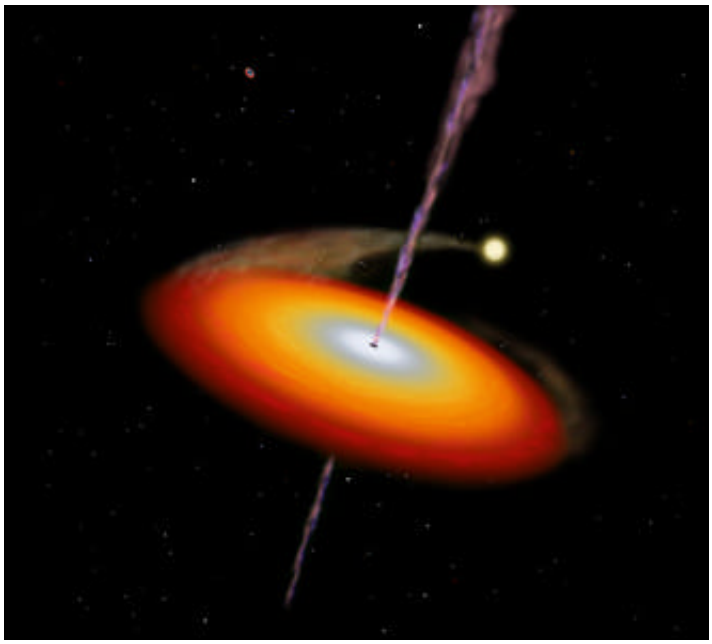
25 March 2003

A Middle Ground for Black Holes?

MOUNT TREMBLANT, QUEBEC--Black holes seem to come in two sizes: small ones with a few times the mass of our sun, and gigantic ones millions to billions of times bigger (*Science*NOW, 24 March 2003). Two teams have now strengthened the controversial case for black holes that inhabit a middle ground, but skeptics say the arguments don't yet tip the scales.



Middle child? In this illustration, a midsize black hole in a nearby galaxy consumes gas from a relatively cool disk.
CREDIT: DAVID A. AGUILAR, HARVARD-SMITHSONIAN CENTER FOR ASTROPHYSICS

The debate dates to 1989, when astronomers first saw powerful beacons of x-rays outside the centers of other galaxies. These sources seemed best explained by hot matter spiraling into black holes tens to thousands of times as massive as the small ones born at the hearts of individual supernova explosions (*Science*NOW, 7 June 2001). Such medium-weight black holes, however, could form only if lots of smaller black holes merged, and theorists aren't sure whether that's possible. To avoid those problems, critics have noted that small black holes could appear very bright in x-rays by channeling all of their energy into narrow beams.

Such beaming now seems less likely, according to studies presented here on 24 March at a meeting of the American Astronomical Society's High-Energy Astrophysics Division. First, a team led by astronomer Jon Miller of the

Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts, used the European Space Agency's XMM-Newton satellite to study two bright x-ray sources in the nearby galaxy NGC 1313. Detailed spectral analysis suggests that the innermost gas around the black holes is relatively cool. That points to black holes with about 1000 times our sun's mass, Miller says, because matter spirals more gently into the larger vortex of a big black hole than into the tiny, steep vortex of a small black hole. Moreover, glowing gas around both objects shows that they radiate in all directions, not just in beams.

Meanwhile, astronomers Tod Strohmayer and Richard Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Maryland, studied a brighter source in the active galaxy M82. The patterns of x-rays recorded by XMM-Newton show that the radiation oscillates every 18 seconds, suggestive of a pulsating disk of matter around a large black hole. XMM also revealed energized iron atoms, spewing x-rays as they plunge into a black hole with perhaps 500 solar masses, Strohmayer maintains. "It's unlikely that radiation from an entire accretion disk could be beamed in one direction" from a smaller black hole, he notes.

"The most natural explanation is intermediate-mass black holes," agrees astronomer Philip Kaaret of CfA. Still, skeptics of midsize black holes are justified in demanding a high standard of evidence, Kaaret notes, because the creation of such objects would be so hard to explain. "These are good arguments, but they are not yet foolproof," comments black hole theorist Ramesh Narayan, also at CfA.

--ROBERT IRION

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Background on midsize black holes
Abstract of Miller *et al.* paper, with link to full text

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